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I, Megumi Nozawa, a translator fluent in the Japanese language, on behalf of Morningside Evaluations and Consulting, do solemnly and sincerely declare that the following is, to the best of my knowledge and belief, a true and correct translation of the document(s) listed below in a form that best reflects the intention and meaning of the original text.

MORNINGSIDE EVALUATIONS AND CONSULTING

Megumi Nozawa

Signature of Translator

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Japanese Patent Application, *Kokai* No.H4-121407, from Japanese to English

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In such design, when said open/close valve 8 closes by responding to an output signal of said controller 9, the exhaust air from the engine 1 passes through each of the first and second exhaust pipes 3 and 4 independently. Thus, in this case, the exhaust noise is reduced only by the muffling effect brought about by each of the mufflers 6, 6. On the other hand, when said open/close valve opens, said exhaust pipes 3 and 4 become in communication through the linking pipe 7, and the exhaust air traveling in the first exhaust pipe 3 and the exhaust air traveling in the second exhaust pipe 4 interfere in the linking pipe 7.

[Original Page (1)]

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(54) Title of the Invention:
ENGINE EXHAUST SYSTEM

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(22) Filing Date: September 11,1990
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SPECIFICATION

1. Title of the Invention

ENGINE EXHASUT SYSTEM

2. What Is Claimed Is:

(1)

An engine exhaust system, wherein a first exhaust path and a second exhaust path, to which the exhaust air is introduced from the engine, are juxtaposed; a secondary muffler having a resonance chamber is provided approximately at the center of the first and second exhaust paths combined; each of said the first and second exhaust paths is divided into a permanent open path and an open/close path at the downstream side from the secondary muffler; the permanent open path and the open/close path formed in each of the exhaust paths are separated and linked to and through a respective different muffler of paired primary mufflers; and open/close valves are placed in said open/close paths.

3. Detailed Explanation of the Invention

[Industrial Fields of Application]

The present invention relates to an engine exhaust system, wherein output characteristics of the engine and muffling characteristics of the exhaust system can be varied.

[Prior Art]

Conventionally, an engine exhaust system shown in Figure 3 was proposed (see the Publication of Unexamined Utility Model Application No. H1-83123). Therein, a first exhaust pipe 3 and a second exhaust pipe 4 are linked to and through manifolds 2, 2 of an engine 1. A catalyst 5, 5 are placed in the exhaust pipes 3 and 4 approximately at the center, and the downstream ends of the exhaust pipes 3 and 4 are linked to and through mufflers 6, 6. A linking pipe 7 is also provided between said exhaust pipes 3 and 4. An open/close valve 8 is placed in the linking pipe 7. It is adapted that the open/close valve 8 is controlled by a controller 9, whose control is based on the number of revolutions of the engine 1.

[Original Page (2)]
Thereby, the exhaust noise is reduced not only by the mufflers 6, 6, but also by the interference effect brought about by the exhaust pipes 3 and 4, so that the noise reduction can be improved.

[Problems to Be Solved by the Invention]

However, in such conventional exhaust system, because said open/close valve 8 is placed in the linking pipe 7, which links to and through the first and second exhaust pipes 3 and 4, either when the open/close valve opens or closes, a cross-sectional area where the exhaust air travels does not change, so that the exhaust air always travels across a fixed exhaust air cross-sectional area defined by the first and second exhaust pipes 3 and 4. Therefore, the exhaust pressure of this exhaust system is always constant whether the open/close valve 8 is opened or closed, so that it is possible to change muffling characteristics by the presence or absence of the interference in the linking pipe 7 but it is not possible to increase output characteristics of the engine by decreasing the exhaust pressure.

Moreover, the muffling effect by the interference develops only in the single linking pipe 7, that is, only in a single space, and hence the degree of the reduction of the exhaust noise is limited, the muffling effect being not satisfactory.

The present invention has been realized to overcome these conventional disadvantages. The purpose of the present invention is to provide an engine exhaust system, wherein both output performance of the engine and muffling performance of the exhaust system can be increased.

[Means for Solving the Problems]

To overcome said disadvantages in the present invention, a first exhaust path and a second exhaust path, to which the exhaust air is introduced from the engine, are juxtaposed; a secondary muffler having a resonance chamber is provided approximately at the center of the first and second exhaust paths combined; each of said the first and second exhaust paths is divided into a permanent open path and an open/close path at the downstream side from the secondary muffler; the permanent open path and the open/close path formed in each of the exhaust paths are separated and linked to and through a respective different muffler of paired primary mufflers; and open/close valves

are placed in said open/close paths.

Namely, the permanent open path from the first exhaust path and the open/close path from the second exhaust path are linked to and through the one primary muffler, and the permanent open path from the second exhaust path and the open/close path from the first exhaust path are linked to and through the other primary muffler.

[Operation of the Invention]

In said design, when said open/close valves are closed, the open/close paths are closed and hence the exhaust air travels only through each of the permanent open paths in the first and second exhaust paths. Accordingly, as compared to when said open/close paths are opened, the exhaust air cross-sectional area across which the exhaust air travels decreases, thereby the exhaust pressure increasing.

Furthermore, when the open/close valves are closed, the open/close paths are closed, serving as branch pipes in communication with the permanent open paths, which are open and the exhaust air travels through. Herein, said branch pipes muffle the exhaust noise having a certain frequency corresponding to the length and the cross-sectional area of the branch pipes by resonator effect. At this time, the secondary muffler also muffles the exhaust noise having another certain frequency by resonator effect of the resonance chamber. Therefore, in this exhaust system, resonator effect by three spaces, that is, said resonance chamber and two branch pipes, each of which is formed with one of the open/close pipes, reduces the exhaust noise.

On the other hand, when said open/close valves are opened, the open/close paths are opened and hence the exhaust air travel through both of the permanent open paths and both of the open/close paths in the first and second exhaust paths. Accordingly, as compared to when said open/close paths are closed, said exhaust air cross-sectional area increases, thereby the exhaust pressure decreasing.

Furthermore, when the open/close valves are opened, the exhaust air from the respective different exhaust path flows into each of the primary mufflers by way of the permanent open path and the open/close path. Thereby, the exhaust noise that arrives into the primary mufflers by way of respective permanent open paths and open/close paths interferes in the respective primary mufflers, in turn the exhaust noise having a certain frequency reducing. Therefore, the interference in each of the primary mufflers, that is, the interference in two separate spaces, increases the reduction of the exhaust

noise, muffling performance over the entire exhaust system increasing.

[Example]

Hereafter, an example of the present invention is explained by referring to the drawings. Namely, an engine 20 shown in Figure 1 has multiple cylinders. The ends of a pair of front tubes, right 21 and left 22, are connected to a manifold.

[Original Page (3)]

The other end of the right tube 21 or the left tube 22 is connected to a right center tube 25 or a left center tube 26 by way of a right catalyst converter 23 or a left catalyst converter 24. Both of the center tubes, right 25 and left 26, go through a secondary muffler 27 having a resonance chamber 40, and have multiple small holes 41 at the section extending into the secondary muffler 27.

To the downstream side of said secondary muffler 27, a right first rear tube 28 serving as a permanent open path and a right second rear tube 29 serving as an open/close path, which are divided from the end of said right center tube 25, are connected in a monolithic manner. In the right second rear tube 29, a right open/close valve A is placed at the location away by l_1 from the junction with the right first rear tube 28. The right open/close valve A is adapted to open or close by an output signal from a controller (not shown).

Moreover, the end of said right first rear tube 28 is linked to and through a right primary muffler 32, and the end of said right second rear tube 29 is linked to and though a left primary muffler 37. A pair of tail tubes 33, 33 extends from each of the right and left primary mufflers 32 and 37.

Furthermore, to the downstream side of said secondary muffler 27, a left first rear tube 34 serving as a permanent open path and a left second rear tube 35 serving as an open/close path, which are divided from the end of said left center tube 26, are connected in a monolithic manner. In the left second rear tube 35, a left open/close valve B is placed at the location away by l_2 ($l_1 \neq l_2$) from the junction with the right first rear tube 28. The left open/close valve B is also adapted to open or close by an output signal from said controller. Herein, in said controller, the number of revolution of the engine is input from a sensor for measuring engine revolution, and such input signal is output to an actuator (not shown). As a result, said open/close valves A and B are adapted to open or close by the actuator. Moreover, the end of said left first rear tube 34 is linked to and thorough said left primary muffler 37, and the end of said left second rear tube 35 is linked to and though said right primary muffler 32.

In addition, in this example, a first exhaust path comprises: the right front tube 21, a right catalyst converter 23, the right center tube 25, the right first and second rear tubes 28 and 29. A second exhaust path comprises: the left front tube 22, a left catalyst converter 24, the left center tube 26, the left first and second rear tubes 34 and 35. Also,

in said engine 20 having multiple cylinders, each of said right front tube 21 and said left front tube 22 is linked to and through a respective manifold of a different cylinder.

In the foregoing design of this example, when both of the open/close valves A and B are closed in response to an output signal from said controller, both of the right and left second rear tubes 29 and 35 are closed. Hence, at the downstream side of the secondary muffler 27, the exhaust air travels only through the right and left first rear tubes 25 and 34, respectively. As compared to when said right and left rear tubes 29 and 35 are opened, the cross-sectional area decreases.

Thereby, as shown in Figure 2, exhaust pressure is higher when both of said open/close valves A and B are closed (I) than when both of said open/close valves A and B are opened (II). Therefore, when both of the open/close valves A and B are closed, firstly, exhaust pressure increases and thereby exhaust resistance increases, resulting in improved muffling performance.

Moreover, when both of the open/close valves A and B are opened, each of the right and left second rear tubes 29 and 35 is closed at a location away by a distance of l_1 or l_2, respectively, from the junction with the first rear tube 28 or 34, respectively, and serves as a branch pipe having a length of l_1 or l_2 in communication with said right first rear tube 28 or said left first rear tube 34, which permanently is open and the exhaust air travels through. Herein, each of the branch pipes muffles the exhaust noise having a certain frequency corresponding to the length l_1 or l_2 and the cross-sectional area of the branch pipe by resonator effect.

At this time, the secondary muffler 27 also muffles the exhaust noise having another certain frequency by resonator effect of the resonance chamber 40. Therefore, in this exhaust system, resonator effect by three spaces, that is, said resonance chamber 40 and two branch pipes having lengths of l_1 and l_2, reduces the exhaust noise.

[Original Page (4)]

Accordingly, when both of the open/close valves A and B are closed, secondly, resonator effect by said three spaces improves muffling performance.

Thus, when both of the open/close valves A and B are closed, first, increased exhaust pressure increases exhaust resistance, and second, said three spaces work as resonators, resulting in improved muffling performance. Noise reduction unattainable by the conventional exhaust system can be realized.

On the other hand, when said open/close valves A and B are opened, both of the right and left second rear tubes 29 and 35 are opened and hence at the downstream side of the secondary muffler 27, the exhaust air travel through both of the right first and second rear tubes 28 and 29, and both of the left first and second rear tubes 34 and 35. Thereby, the exhaust air cross-sectional area increases. As shown in Figure 2, exhaust pressure is lower when both of said open/close valves A and B are opened (II) than when both of said open/close valves A and B are closed (I). As a result, when both of said open/close valves A and B are opened, exhaust pressure decreases, resulting in improved output performance of the engine 1 [*sic.*: should be engine 20 according to Figure 1 (Translator's Note)].

Furthermore, when the open/close valves A and B are opened, into the right primary muffler 32, introduced are the exhaust air from said right front tube 21 by way of the right first rear tube 28, and the exhaust air from said left front tube 22 by way of the left second rear tube 35.

At this time, in said engine 1 [*sic.*: engine 20 (Translator's Note)] having multiple cylinders, each of said right and left front tubes 21 and 22 are linked to and through a respective manifold of a different cylinder. Hence, a difference in phase occurs due to a difference in explosion timing of the cylinders between the exhaust noise reaching into the right primary muffler 32 by way of the right first rear tube 28 and the exhaust noise reaching into the right primary muffler 32 by way of the left second rear tube 35. Thereby, the exhaust noise that arrives into the right primary muffler 32 by way of said right first rear tube 28 and said left first rear tube 35 interferes in the right primary muffler 32, in turn the exhaust noise having a certain frequency reducing.

On the other hand, into the left primary muffler 37, introduced are the exhaust air from said left front tube 22 by way of the left first rear tube 34, and the exhaust air from said right front tube 21 by way of the right second rear tube 29. At this time,

because a difference in phase occurs, as mentioned above, between the exhaust noise reaching into the left primary muffler 37 by way of the left first rear tube 34 and the exhaust noise reaching into the left primary muffler 37 by way of the right second rear tube 29, likewise the exhaust noise having a certain frequency interferes in the left primary muffler 37 and reduces.

Therefore, the interference in each of the right and left primary mufflers 32 and 37, that is, the interference in two separate spaces, increases the reduction of the exhaust noise, and thereby muffling performance over the entire exhaust system can be increased. Also, such reduction in noise having certain frequencies is attainable, and hence basic degree components (in case of a V6 engine, 3rd, 6th, and 9th degree components) are kept while 1.5th and 4.5th degree components are reduced, so that an exhaust noise in which only said basic degree components are emphasized can be generated. Thereby, an exhaust noise that is crisp but not annoying may be obtained as well.

Moreover, as shown in Figure 2, the exhaust pressure characteristic when one of said open/close valves A and B is opened (III) falls between said exhaust pressure characteristics (I) and (II). When one of said open/close valves A and B is opened, output performance of the engine 20 and muffling performance of the exhaust system exhibit such exhaust pressure characteristic (III). Also, in this example, $l_1 \neq l_3$ is assumed, but $l_1 = l_3$ is possible; and the right primary muffler 32 and the left primary muffler 37 may have different characteristics or the same characteristic.

[Effects of the Invention]

As has been explained, in the present invention, at the downstream side from the secondary muffler having the resonance chamber, from each of the exhaust air paths, divided are each of the permanent open paths and the open/close paths in which open/close valves are placed; the permanent open path and the open/close path from each of the exhaust air paths are linked to and through the respective different muffler of the paired primary mufflers; hence, by closing said open/close valves, the exhaust air cross-sectional area can be decreased. Accordingly, when both of the open/close valves are closed, firstly, said decrease in exhaust air cross-sectional area causes an increase in exhaust pressure, and thereby exhaust resistance increases, resulting in improved muffling performance.

[Original Page (5)]

Also, when both of the open/close valves are closed, each of the open/close paths serve as branch pipes from the permanent open paths. Each of the branch pipes, corresponding to the length and cross-sectional area, muffle the exhaust noise having a certain frequency by resonator effect. At this time, the secondary muffler also muffles a certain frequency by resonator effect. Therefore, in this exhaust system, resonator effect by three spaces of said resonance chamber and each of the branch pipes reduces the exhaust noise. Therefore, when both of the open/close valves are closed, secondly, resonator effects by said three spaces improves muffling performance.

As a result, when the both of the open/close valves are closed, first, increased exhaust pressure increases exhaust resistance, and second, said three spaces work as resonators, resulting in improved muffling performance. Noise reduction unattainable by the conventional exhaust system can be realized.

On the other hand, when both of said open/close valves are opened, at the downstream side from the secondary muffler, the exhaust air can travel through both of the permanent open paths and open/close paths. Thereby, the exhaust air cross-sectional area increases and in turn exhaust pressure decreases, resulting in improved output performance of the engine.

Additionally, when both of the open/close valves are opened, into each of the primary mufflers, the exhaust air from each of the first exhaust path and the exhaust air from each of the second exhaust path are introduced. Hence, the exhaust noise arriving into each of the primary mufflers interferes, in turn the exhaust noise reducing. Therefore, the interference in each of the primary mufflers, that is, the interference in two spaces, increases the reduction of the exhaust noise. When both of the open/close valves are opened, muffling performance over the entire exhaust system can be increased as well.

Moreover, as a result that the exhaust noise having a certain frequency can be reduced, an exhaust noise in which only said basic degree components are emphasized can be also generated. Thereby, an exhaust noise that is crisp but not annoying may be obtained as well.

[Brief Description of the Drawings]

Figure 1 is a conceptual view illustrating the entirety of an example of the present invention.

Figure 2 illustrates exhaust pressure characteristics of the example.

Figure 3 is a conceptual view of the conventional exhaust system of an engine.

20 ·····engine
21 ·····right front tube
22 ·····left front tube
23 ·····right catalyst converter
24 ·····left catalyst converter
25 ·····right center tube
26 ·····left center tube
27 ·····secondary muffler
28 ·····right first rear tube (permanent open path)
29 ····· right second rear tube (open/close path)
32 ····· right primary muffler
34 ····· left first rear tube (permanent open path)
35 ····· left second rear tube (open/close path)
37 ····· left primary muffler
A ····· right open/close valve
B ····· left open/close valve

Agent: Miyoshi, Chiaki; Patent Attorney

Figure 2

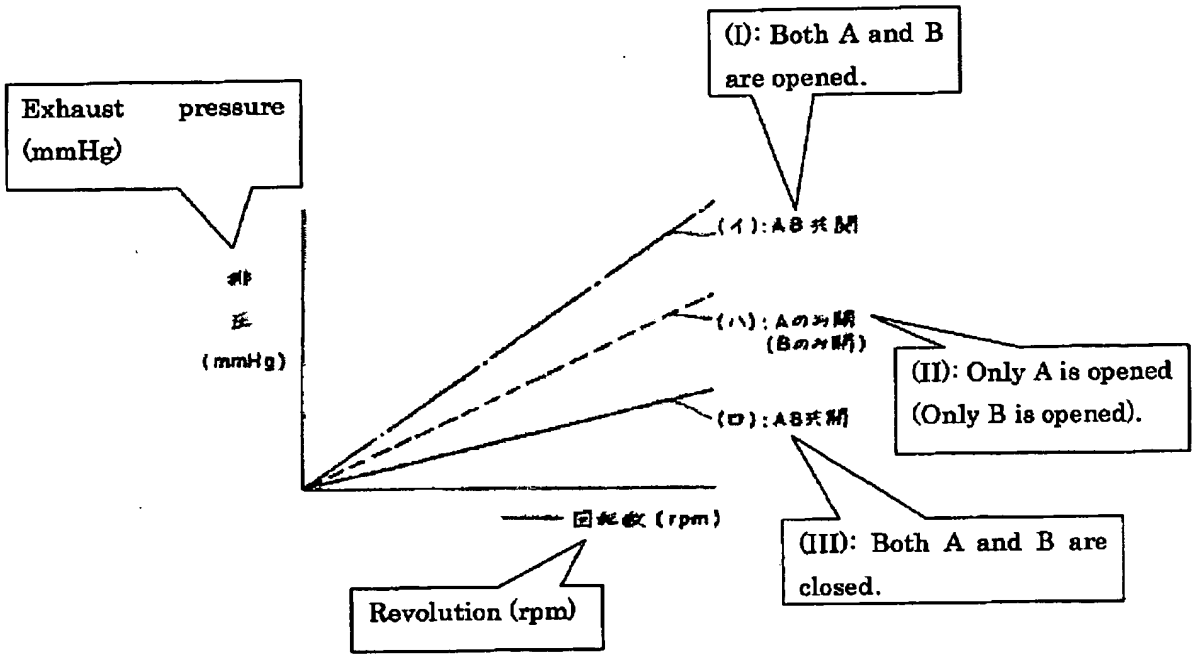
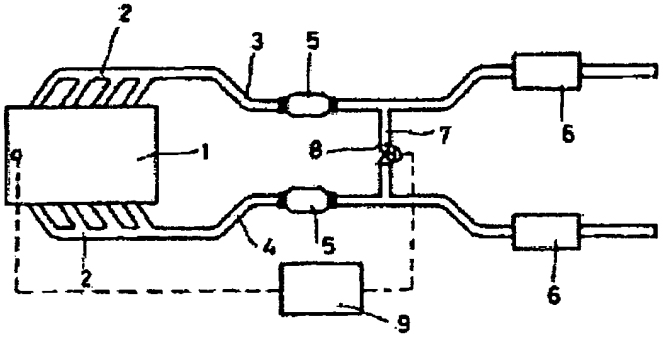
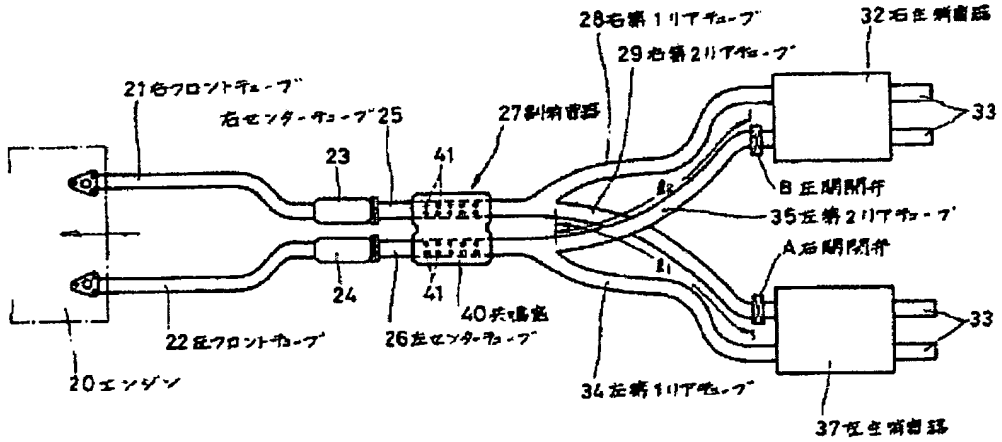


Figure 3



[Original Page (6)]

Figure 1



20 ·····engine
21 ·····right front tube
22 ·····left front tube
25 ·····right center tube
26 ·····left center tube
27 ·····secondary muffler
28 ·····right first rear tube
29 ·····right second rear tube
32 ·····right primary muffler
34 ·····left first rear tube
35 ·····left second rear tube
37 ·····left primary muffler
40 ·····resonance chamber
A ·····right open/close valve
B ·····left open/close valve